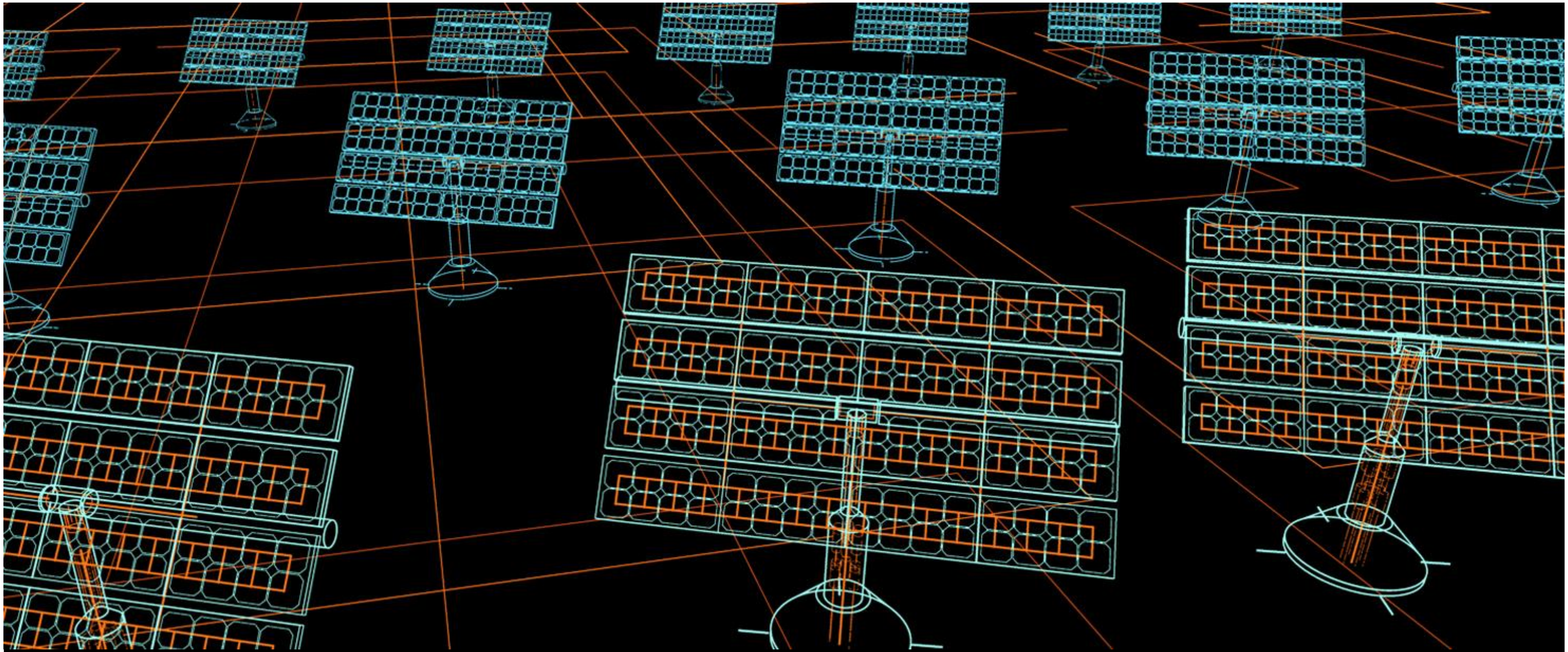


ABB Power Generation, 2012-02-20

Microgrids & Renewable Integration
The ABB PowerCorp Story

Introduction ABB Renewable Energy Integration
Mission

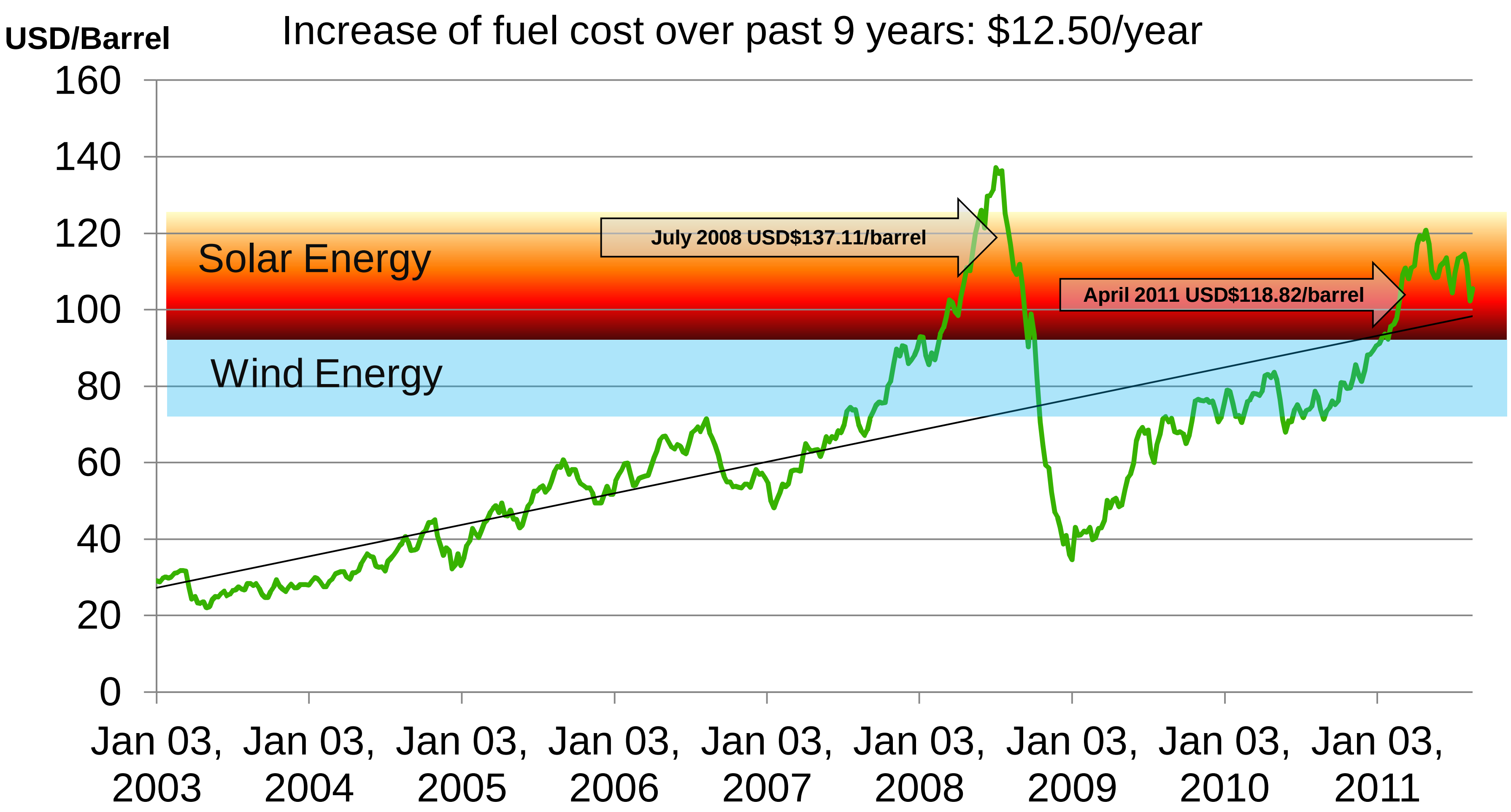
Power system integrator who designs, supplies and constructs Renewable Energy Power Stations

Enable organisations to make the transition from fossil fuel based generation to Renewable energy based generation

Specialists in high penetration of

wind and/or solar in diesel/gas plants

Introduction ABB Renewable Energy Integration
Why Renewables ?



Source: US Energy Information Administration – Independent Statistics and Analysis
www.eia.gov

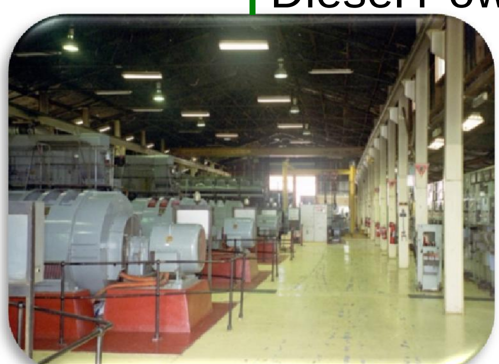
Introduction ABB Renewable Energy Integration
Market Offering

Solarfarm

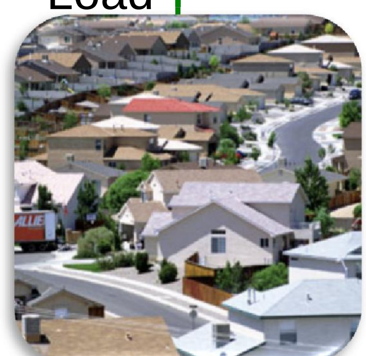
Windfarm

Offering: Renewable Energy Integration

Diesel Power Station



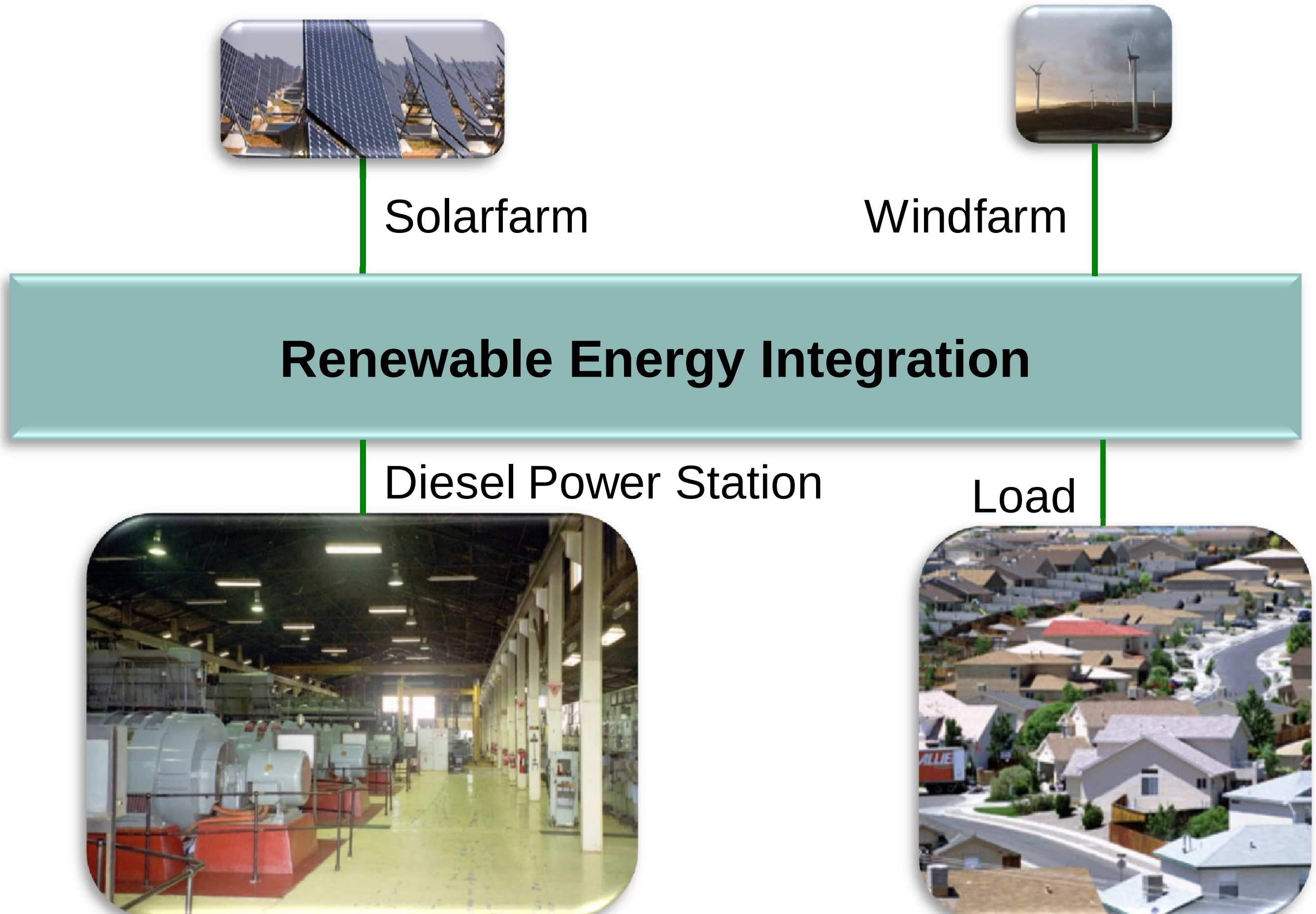
Load



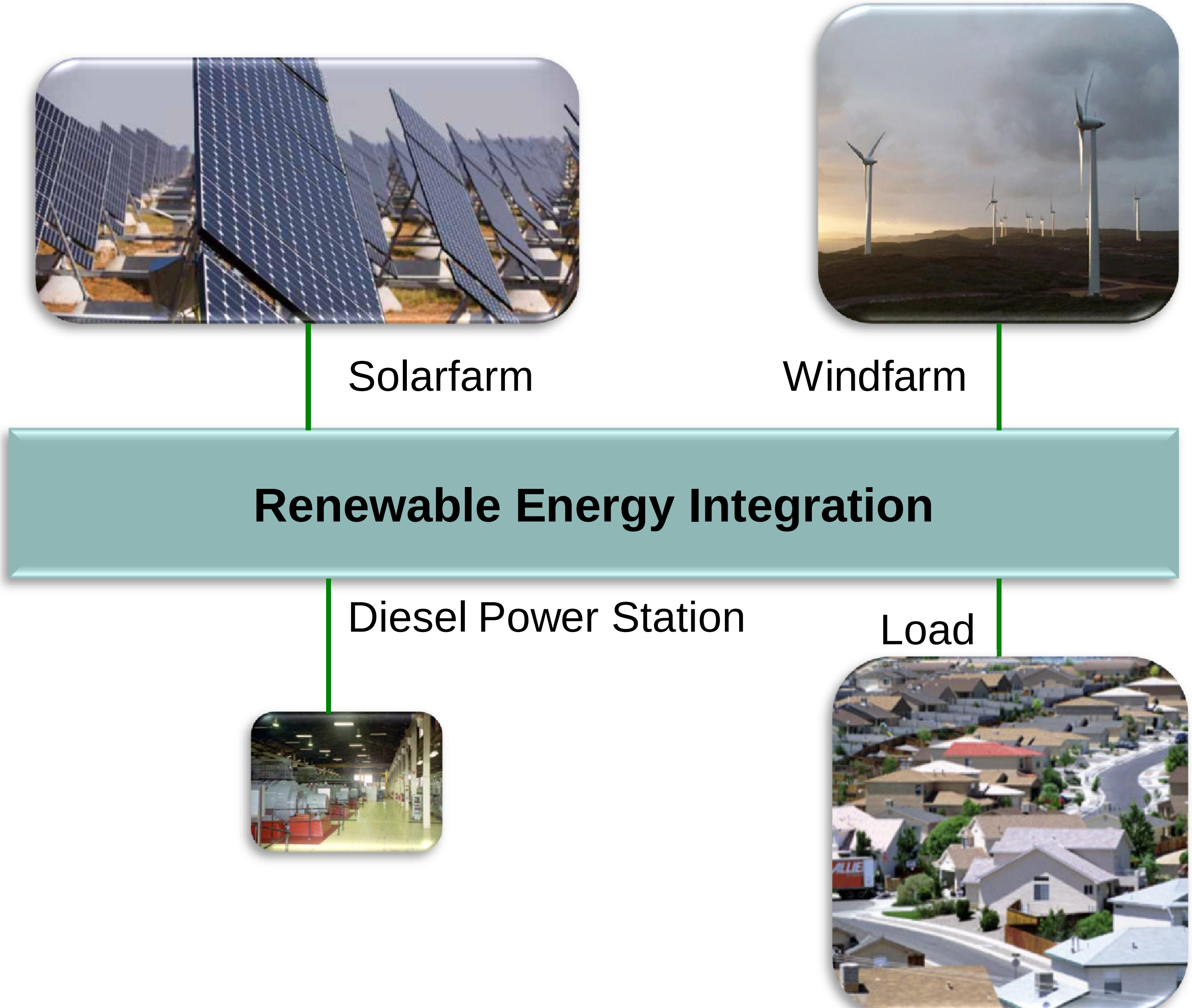
Renewable Energy Integration Challenges
The Diesel Power Station

- Frequency & Voltage Control
- Fault Current
- System Inertia
- Spinning Reserve
- Step Load (load increase & reject)
- Unbalanced load supply
- Firm Capacity
- Active & Reactive Power Supply
- Loadsharing between generators
- Automatic dispatch control

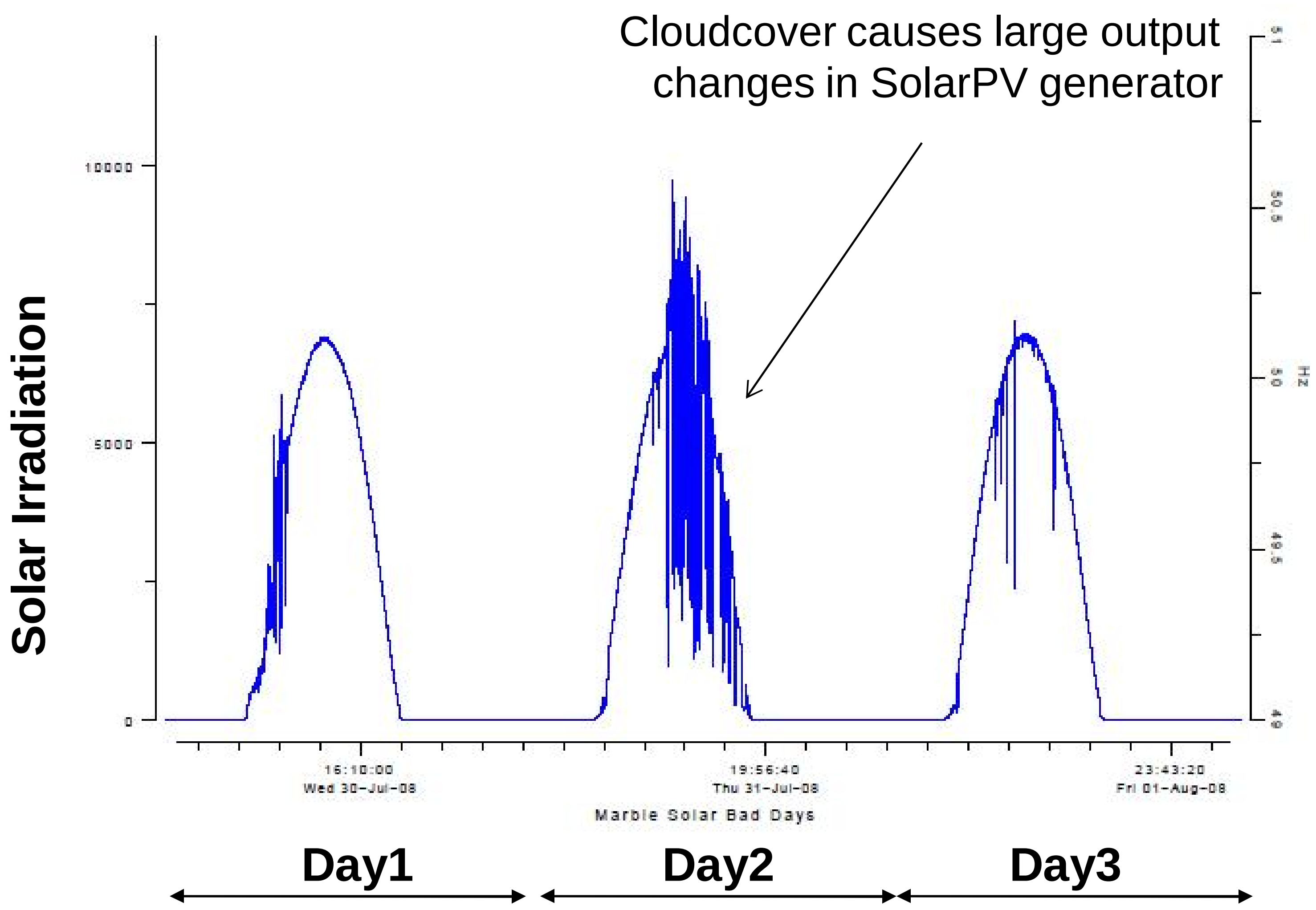
Renewable Energy Integration Challenges
Low Penetration System – 10-20% (annual average 5-10%)



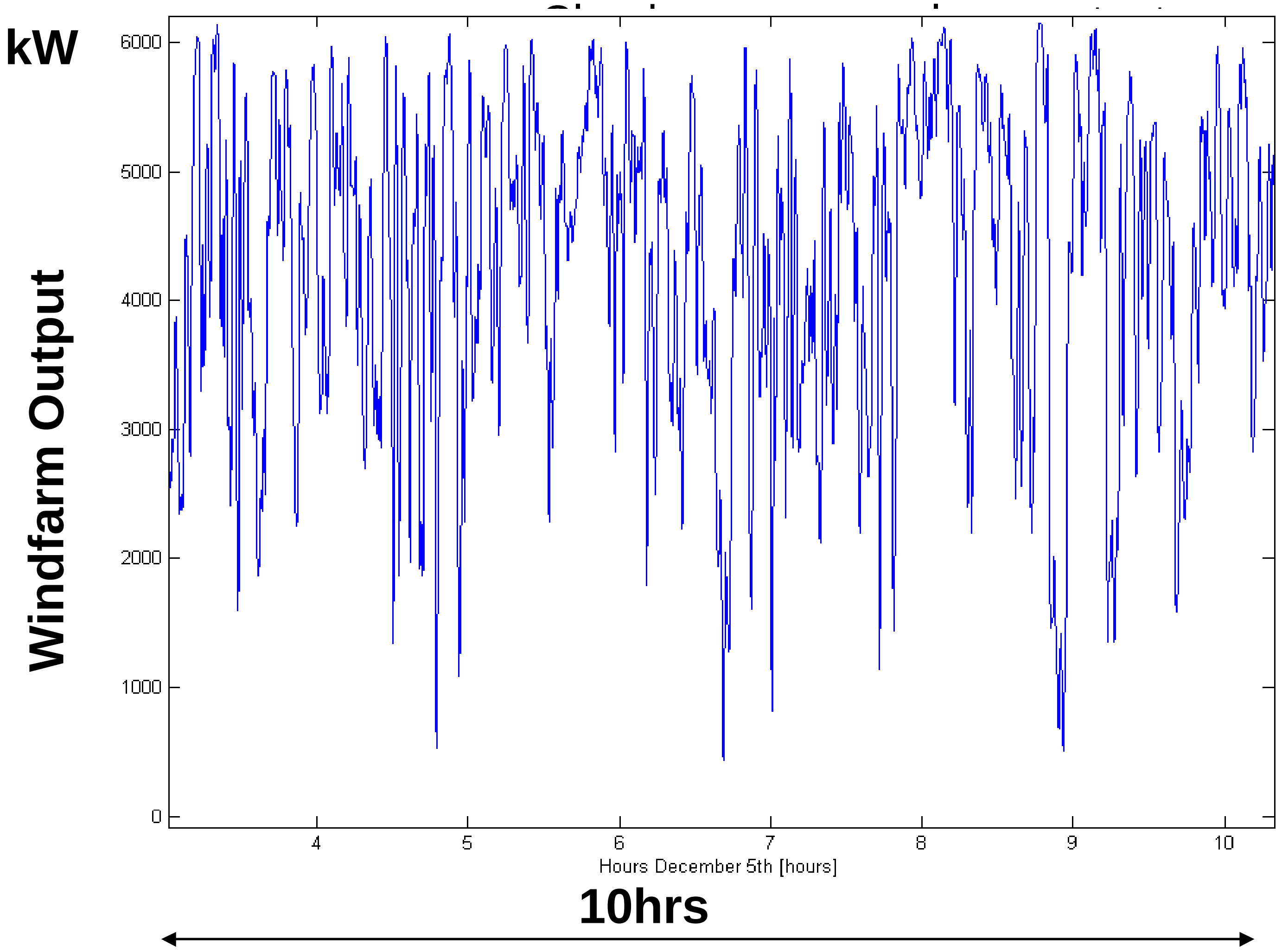
Renewable Energy Integration Challenges
High Penetration System – 100% (annual average 40-60%)



Renewable Energy Integration Challenges
Managing solar power output fluctuations



Renewable Energy Integration Challenges
Managing wind power output fluctuations

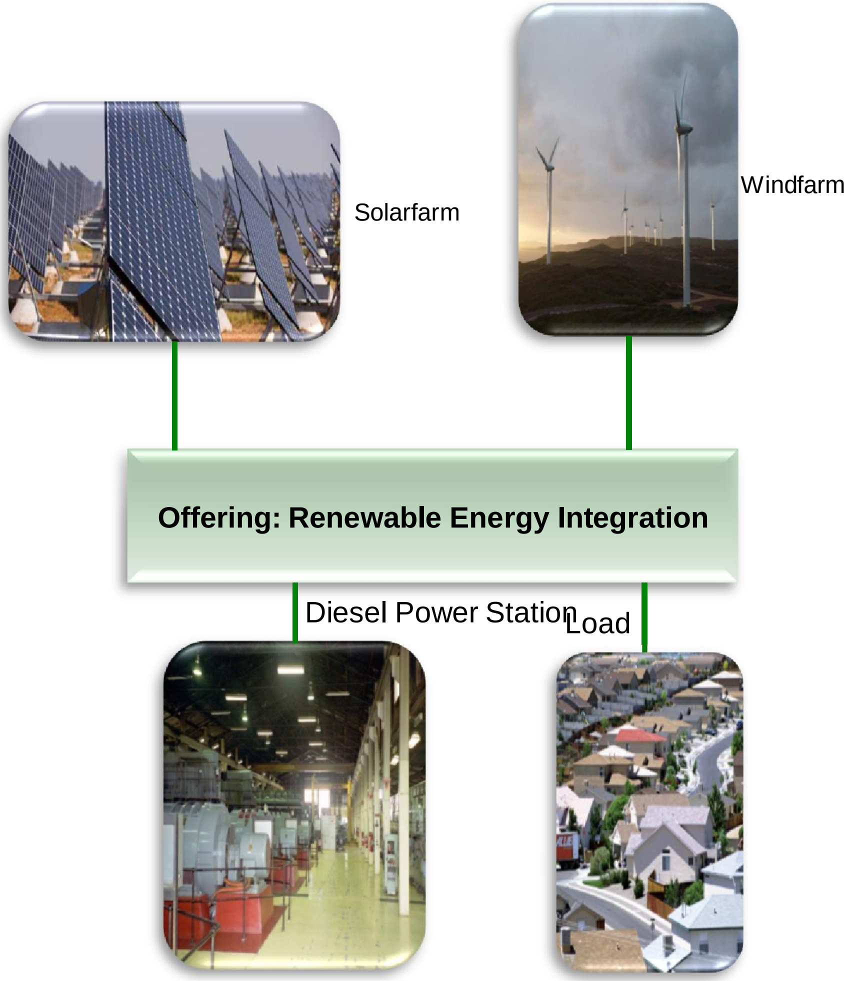


Renewable Energy Integration Challenges
.....keeping the system together

Wind/SolarPV/Diesel System

- Spinning Reserve
- Unbalanced load supply

- Active & Reactive Power Supply
- Loadsharing between generators
- Automatic dispatch control



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Solutions to Integration

Microgrid Technology Solutions - Typical penetration levels

Wind/Solar/Diesel Systems	Annual Average Penetration	Peak Penetration
No Integration	7-10%	20%
Automated Dispatch	10-15%	22%
Grid Stabilising	40-60%	100%
Automated Demand Response	60-80%	100%
Energy Storage	100%	100%

ABB Powercorp
”Enables” Renewable Energy Solutions

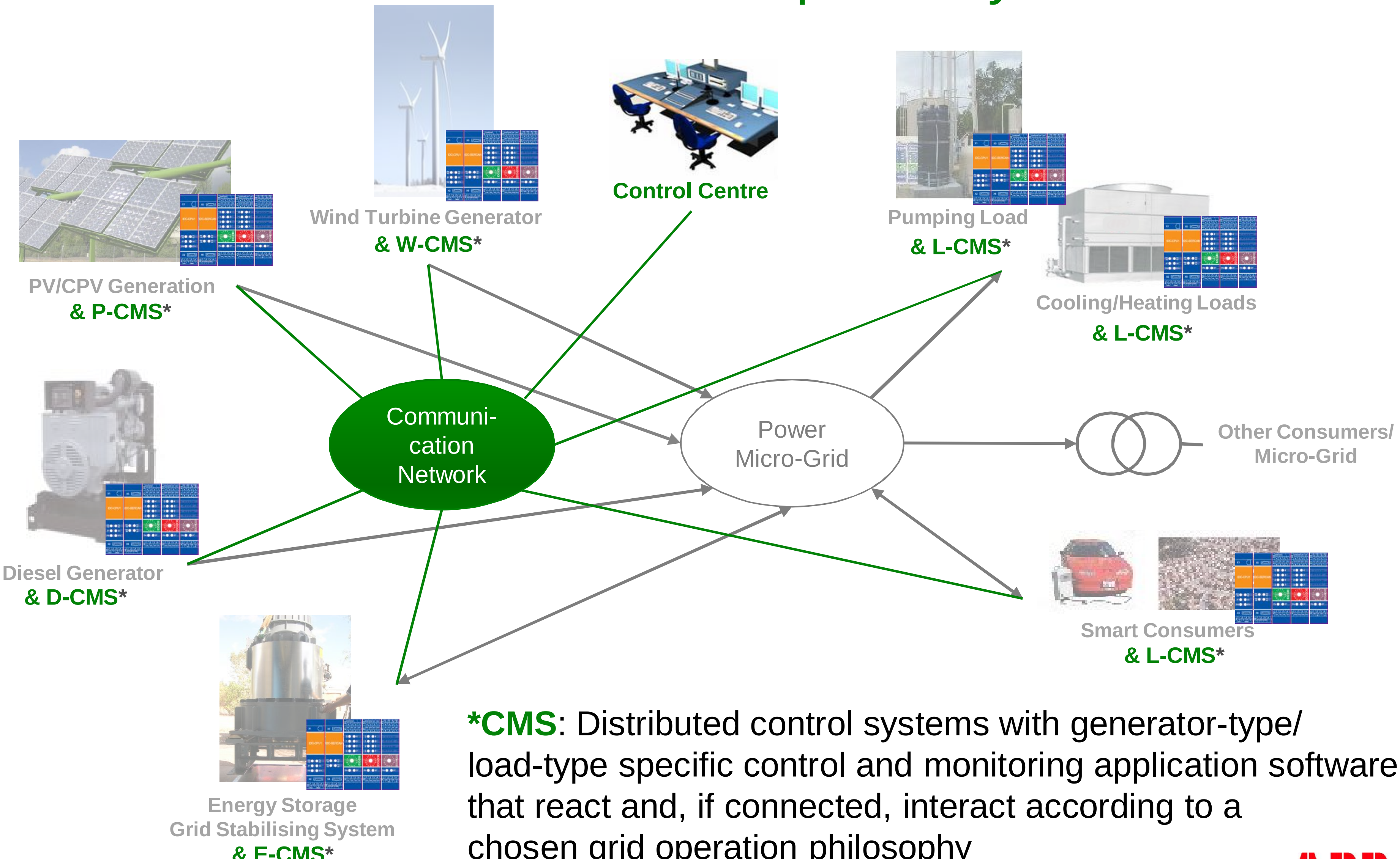
By means of :

- Control / automation
  - Distributed Power Control and Dispatch Systems
  - SMART GRID
- Grid stabilising
  - Using flywheel, battery and power inverter technology
- System simulation and engineering design
  - Up front consulting to verification

Proven by :

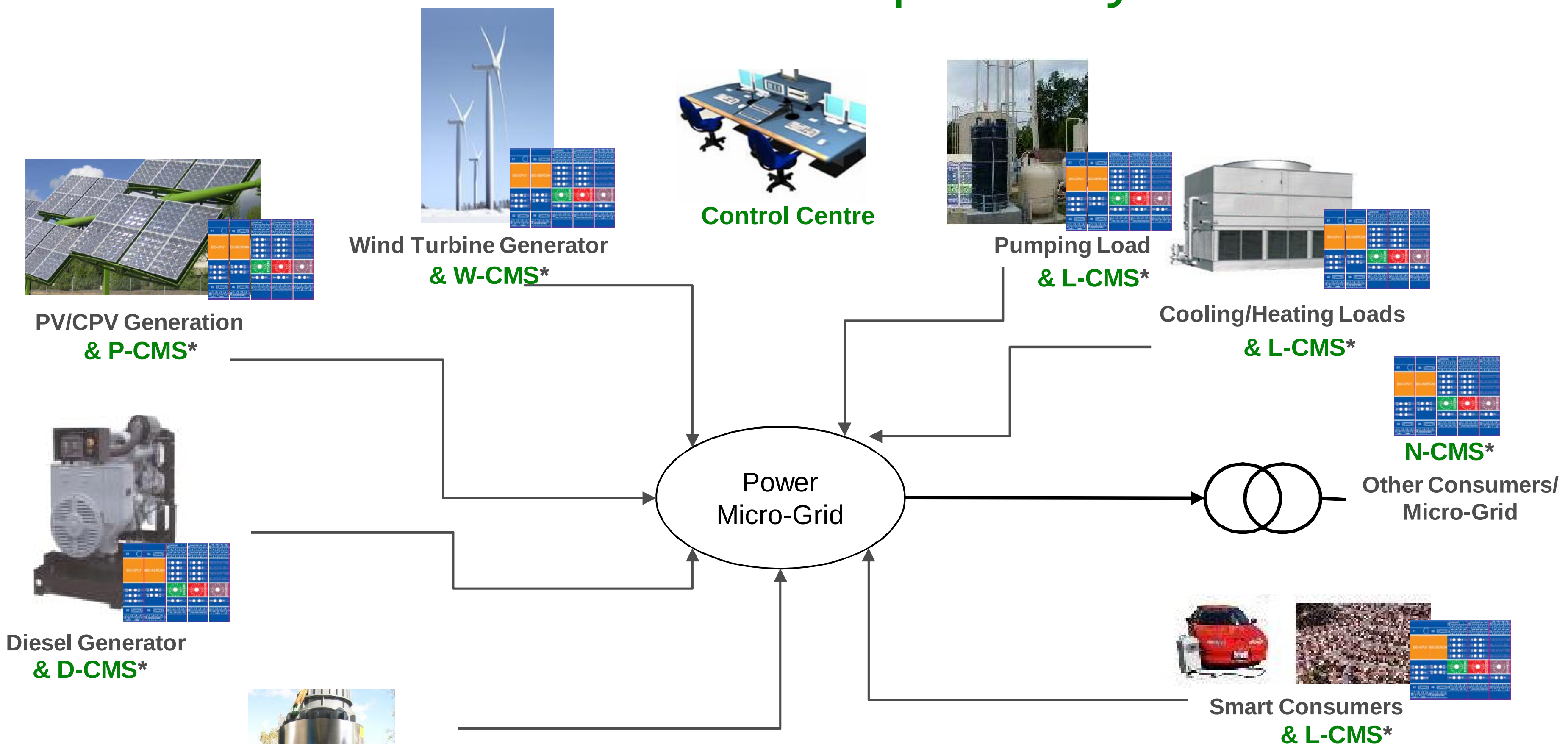
- Delivered world’s only **“Fully automatic, Commercial, Reliably operating”** high penetration wind/diesel stations
- Delivered the first “**Commercial scale and Fully automatic”** high penetration solar/diesel plants

System Offering
Distributed Power Control & Dispatch System



***CMS**: Distributed control systems with generator-type/ load-type specific control and monitoring application software that react and, if connected, interact according to a chosen grid operation philosophy

System Offering
Distributed Power Control & Dispatch System



***CMS**: Distributed control systems with generator-type/ load-type specific control and monitoring application software that react and, if connected, interact according to a chosen grid operation philosophy

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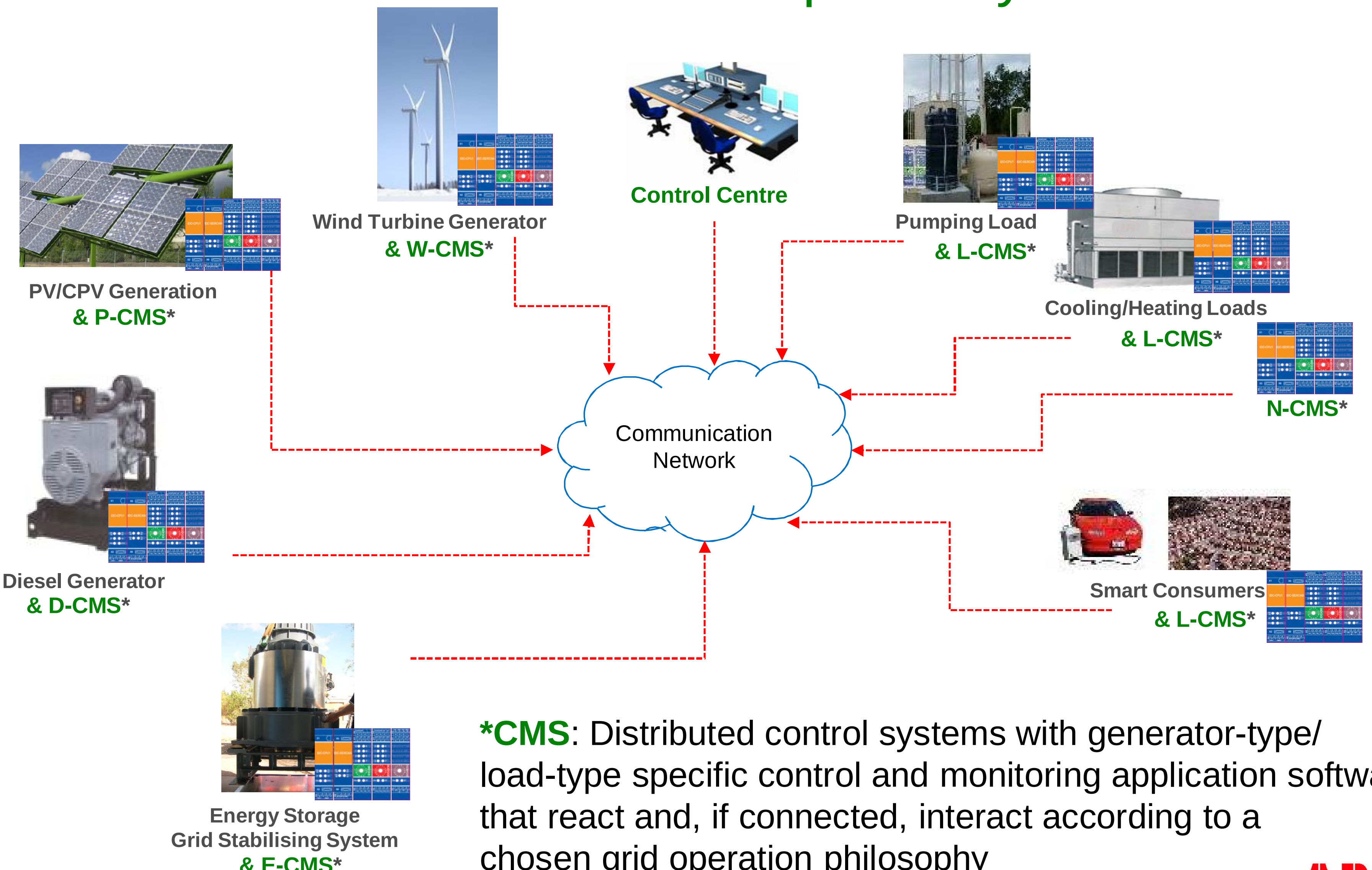
System Offering
Distributed Power Control & Dispatch System

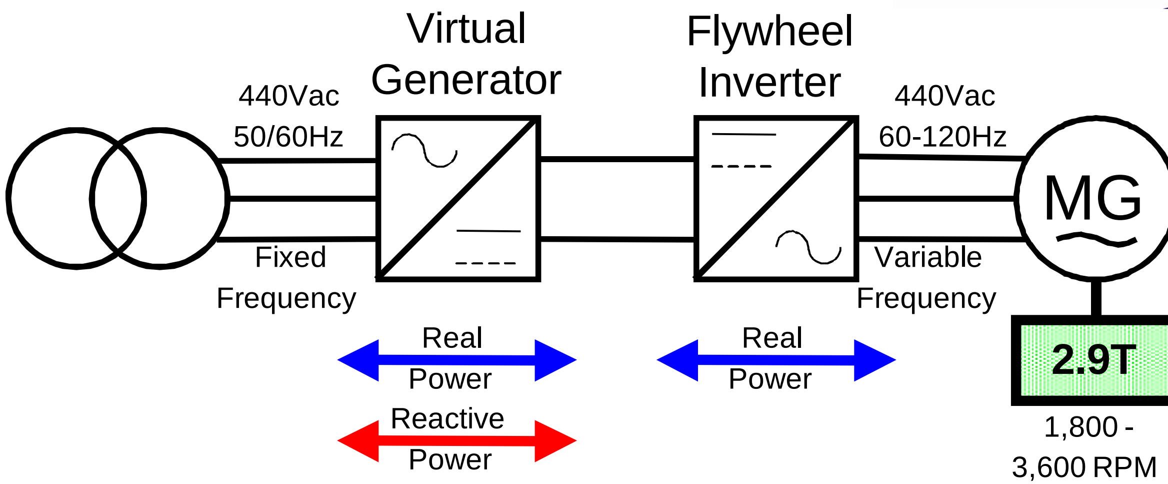


***CMS**: Distributed control systems with generator-type/ load-type specific control and monitoring application software that react and, if connected, interact according to a chosen grid operation philosophy

Microgrid Technology Solutions
PowerStore-Flywheel System

Features

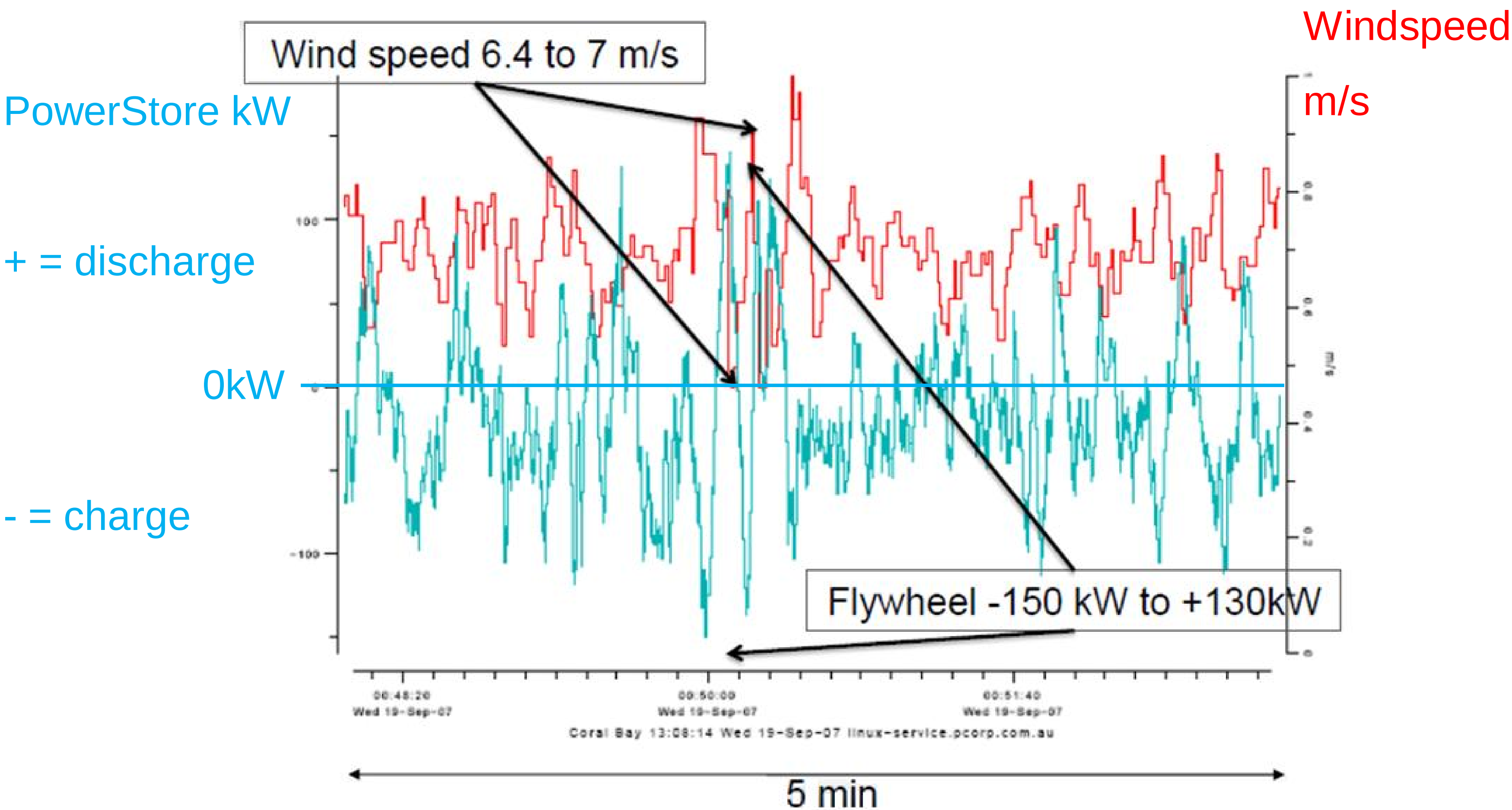
- Grid Stabilising
- Scalable & Modular
- Frequency Control
- Introducing SYNTHETIC INERTIA
- Voltage Control
- Fault ride through
- Grid forming



Inverters 100– 1,650 kVA

18 MWs flywheel

Offering
What the PowerStore does



Experience and References
History

1990	1998	2001	2007	2010
Napperby Northern Territory	Denham Western Australia	Mawson Antarctica	Coral Bay Western Australia	Marble Bar & Nullagine Western Australia
Automation of Diesel Power Station (Battery System)	Wind/Diesel	Wind/Grid Stabilising	Wind/Diesel/ Flywheel	Solar/Diesel/ Flywheel
0% Penetration	15% Penetration	85% Penetration	95% Penetration	100% Penetration

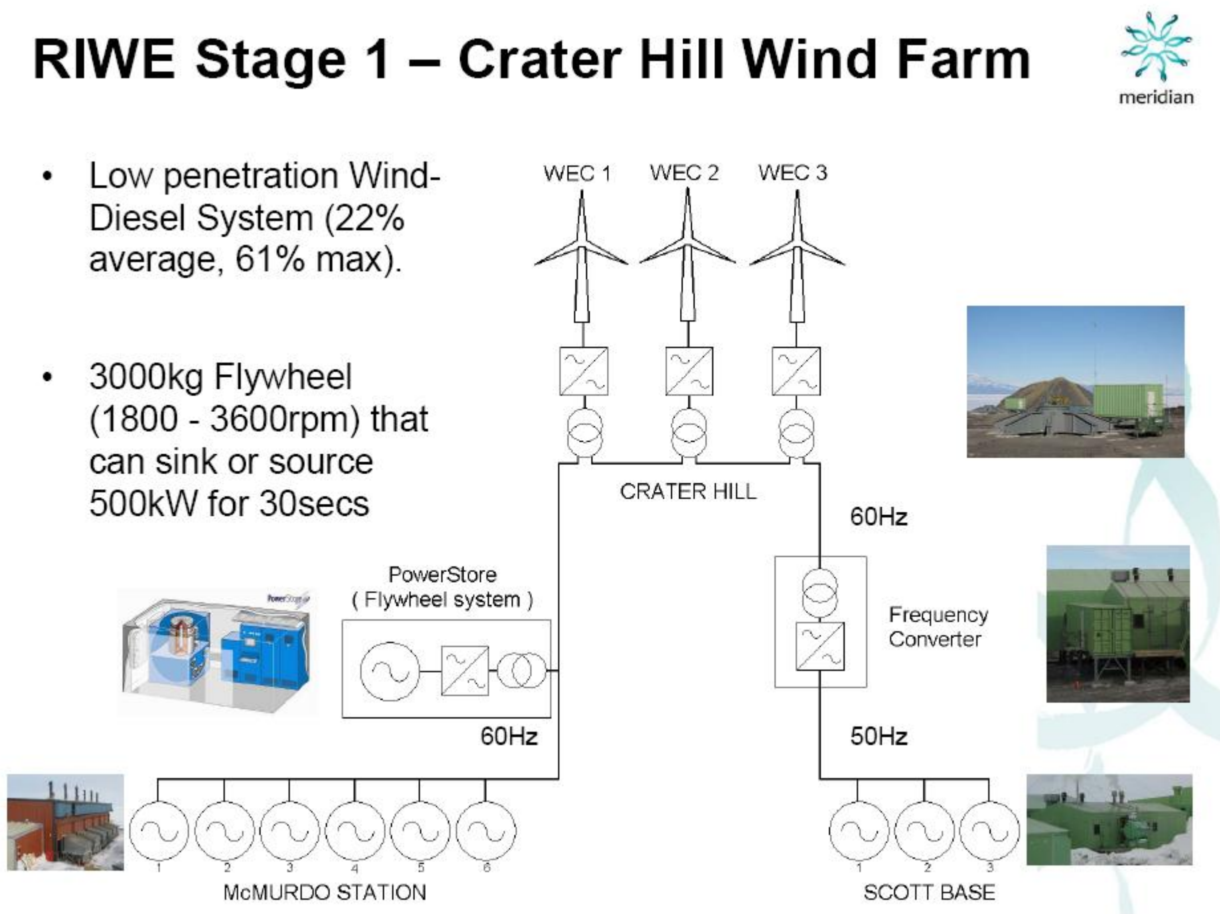




Penetration is annual average renewable energy as percentage of total energy generated

Project Experience
Ross Island, Wind/Diesel System Antarctica

Stage 2 plans are to increase the number of wind turbines, creating a high penetration system



Project Experience
Ross Island, Wind/Diesel System Antarctica

- 1. Two power systems coupled by frequency converter:
  - 6 x 1500kW/60Hz diesel
  - 3 x 225kW/50Hz diesel
  - 3 x 330kW wind turbines
  - 1 x 500kW flywheel
- 2. Option to include electric heating load
- 3. Integration of US/NZ power system network

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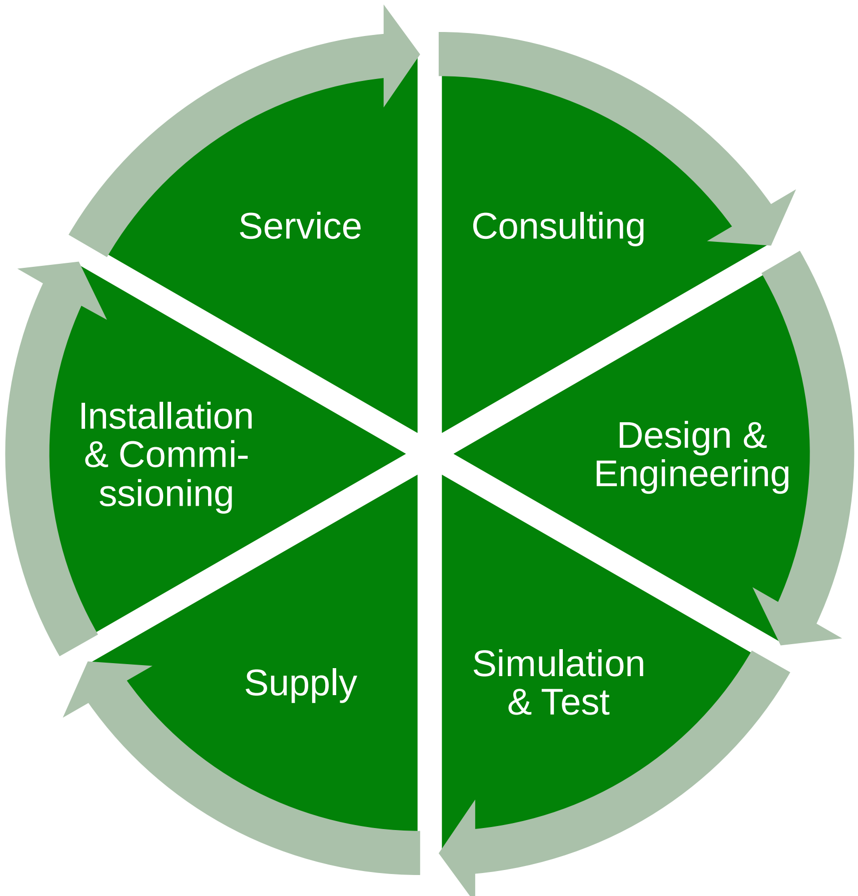
Project Experience
Marble Bar, Solar/Diesel System Australia

- 1. Power system consisting of:
  - 5 x 320kW Diesel
  - 1 x 300kW PV
  - 1 x 500kW Flywheel
- 2. PV/Diesel system without battery storage
- 3. Opportunity to deploy load control to maximise PV penetration
- 4. 100% Penetration

Project Experience
Marble Bar, Solar/Diesel System Australia

"The Project is supported by the Australian Government through the Renewable Remote Power Generation Program. The Program is implemented by the State's Office of Energy in Western Australia".

System Offering
Renewable Energy Integration – Complete Value Chain



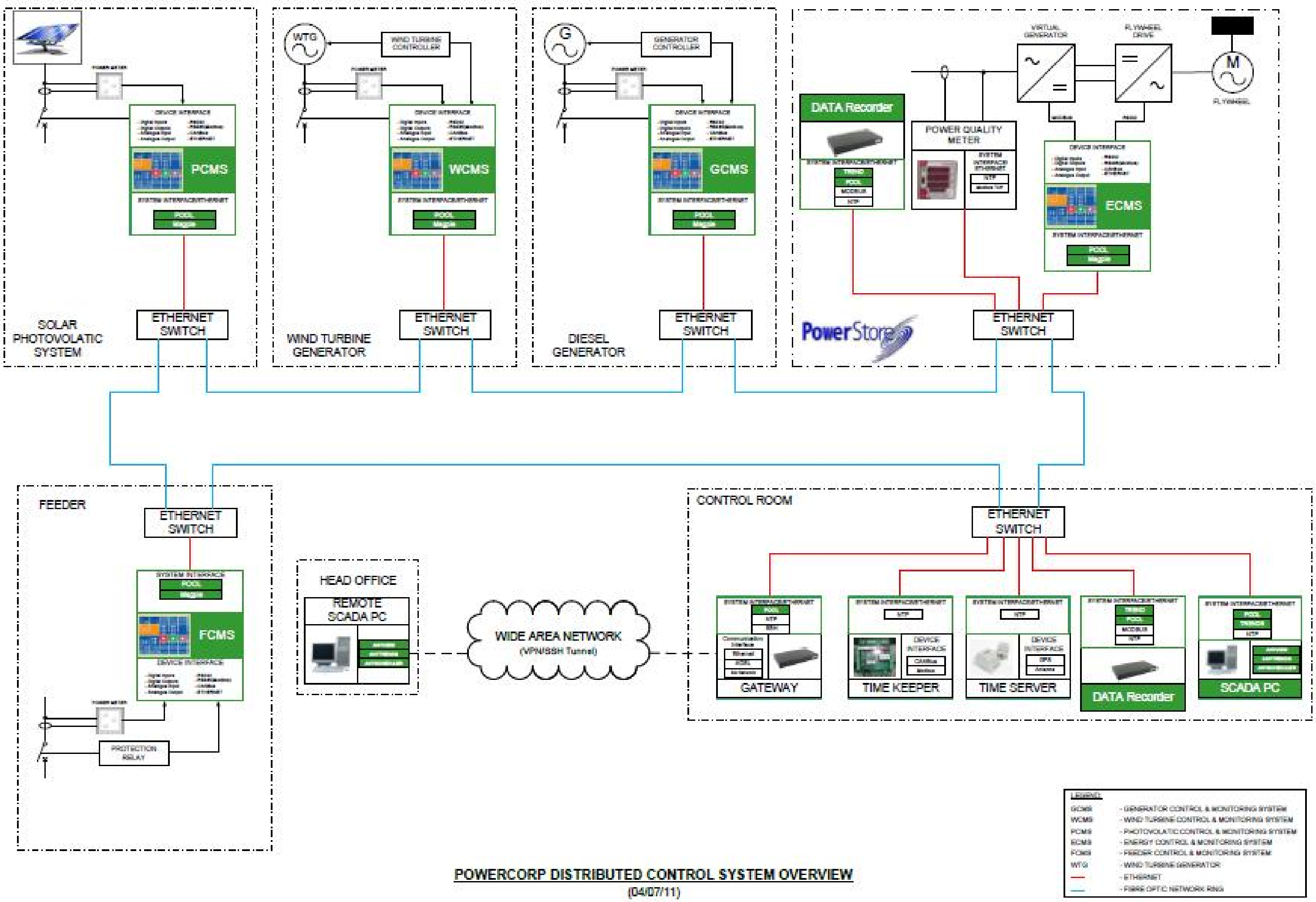
- Modelling
- Design
- Specification
- Training

- Equipment Supply
- Project Management
- Installation

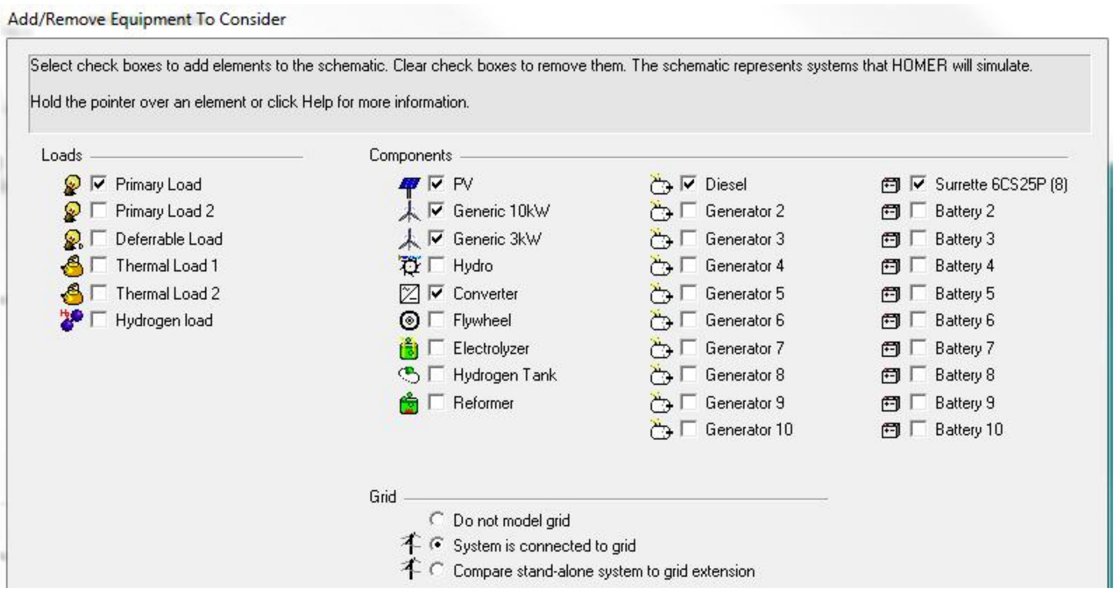
- Strategy & Management
- Acceptance Testing
- Handover

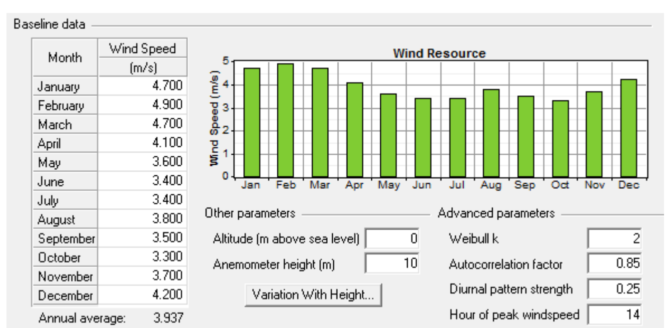
- Service
- Support
- Operation
- Training
- Reporting

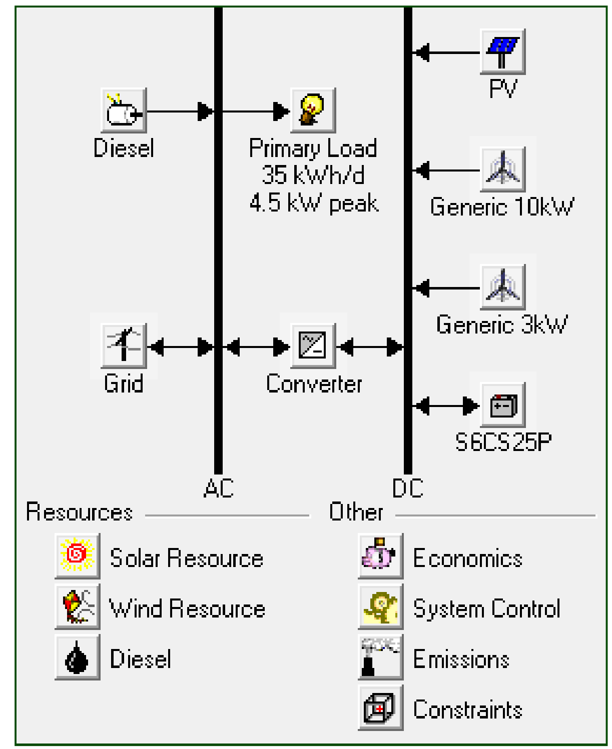
Offering
A DCS example



Offering
Energy Modelling

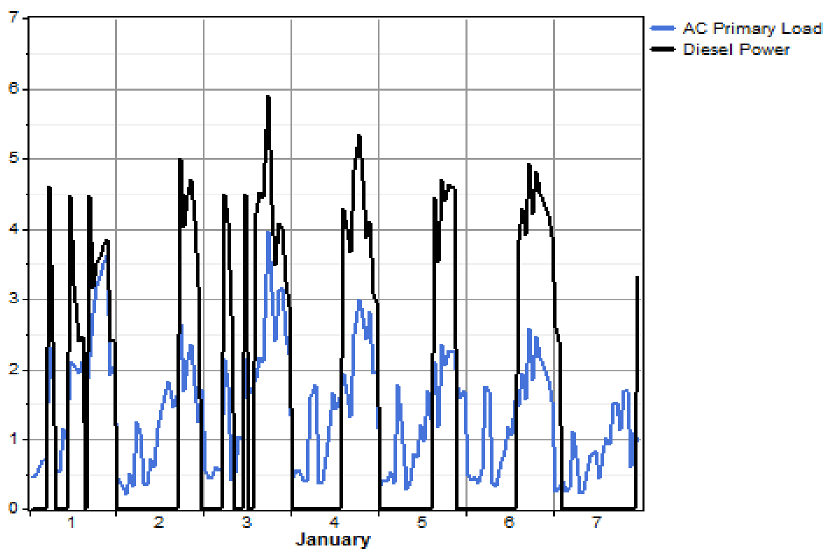


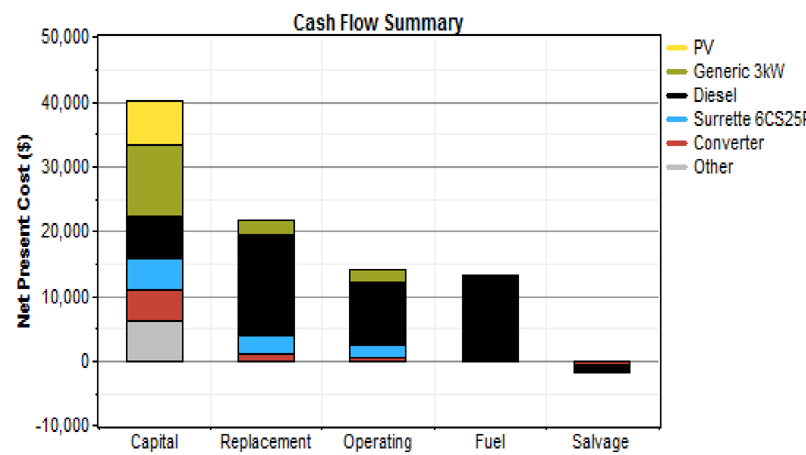




Offering
Energy Modelling

						PV (kW)	G10	G3	Dsl (kW)	S6CS25P	Conv. (kW)	Disp. Strgy	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Dsl (hrs)
									8	8	2	CC	$ 24,600	5,279	$ 80,947	0.594	0.00	0.00	6,363	3,826
						1			8	8	2	CC	$ 31,500	4,794	$ 82,673	0.606	0.11	0.00	5,638	3,490
								1	8	8	2	CC	$ 35,600	5,494	$ 94,250	0.691	0.05	0.00	6,091	3,740
						1		1	8	8	2	CC	$ 42,500	5,012	$ 96,005	0.704	0.15	0.00	5,378	3,398
									8			CC	$ 12,500	9,221	$ 110,936	0.813	0.00	0.00	11,049	8,760
						1			8		2	CC	$ 21,900	9,247	$ 120,607	0.884	0.07	0.00	11,025	8,744
								1	8		2	CC	$ 26,000	9,625	$ 128,748	0.944	0.03	0.00	11,022	8,752
						1		1	8		2	CC	$ 32,900	9,568	$ 135,032	0.990	0.10	0.00	10,954	8,700
						12	2			40	6	CC	$ 194,300	5,293	$ 250,799	1.839	1.00	0.00		



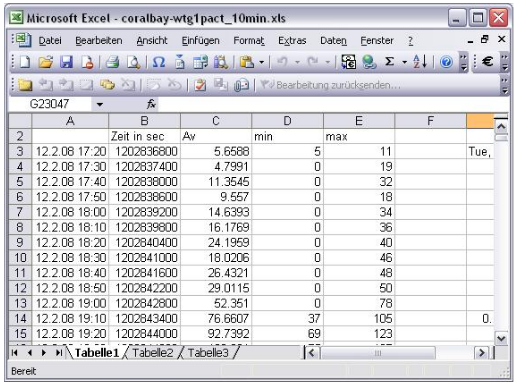


Offering
Dynamic Stability & Control Modelling

Input
e.g. **v_{WIND}(t), ...** → **Power System Dynamic Model** → **Output: U(t), f(t), ...**

Power System Dynamic Stability Modelling (transients, disturbances ...)

Recorded data from real system:


Microsoft Excel - coralbay-wtg1pact_10min.xls

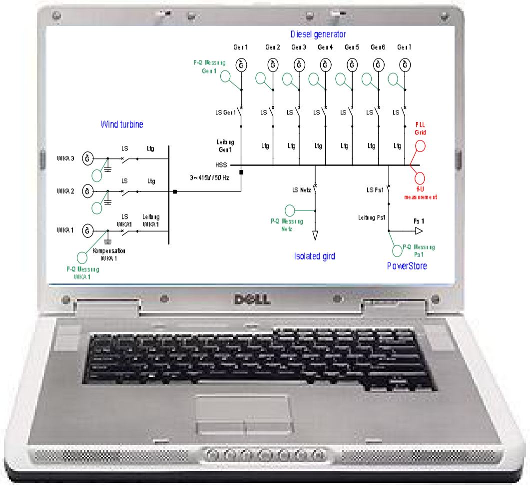
Datei Bearbeiten Ansicht Einfügen Format Extras Daten Fenster ?

G23047

	A	B	C	D	E	F
2		Zeit in sec	Av	min	max	
3	12.2.08 17:20	1202836800	5.6588	5	11	Tue,
4	12.2.08 17:30	1202837400	4.7991	0	19	
5	12.2.08 17:40	1202838000	11.3545	0	32	
6	12.2.08 17:50	1202838600	9.557	0	18	
7	12.2.08 18:00	1202839200	14.6393	0	34	
8	12.2.08 18:10	1202839800	16.1769	0	36	
9	12.2.08 18:20	1202840400	24.1959	0	40	
10	12.2.08 18:30	1202841000	18.0206	0	46	
11	12.2.08 18:40	1202841600	26.4321	0	48	
12	12.2.08 18:50	1202842200	29.0115	0	50	
13	12.2.08 19:00	1202842800	52.351	0	78	
14	12.2.08 19:10	1202843400	76.6607	37	105	0.
15	12.2.08 19:20	1202844000	92.7392	69	123	

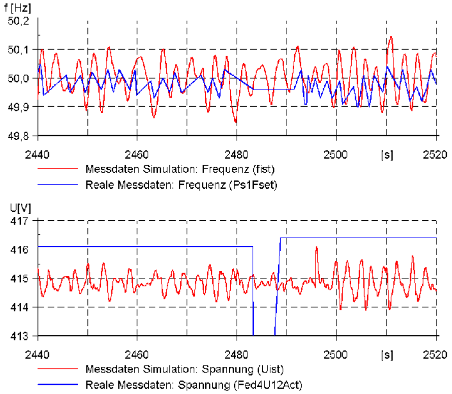
Tabelle1 / Tabelle2 / Tabelle3

Bereit



Simulation tool

Output of Simulation (Voltage, Frequency, etc)



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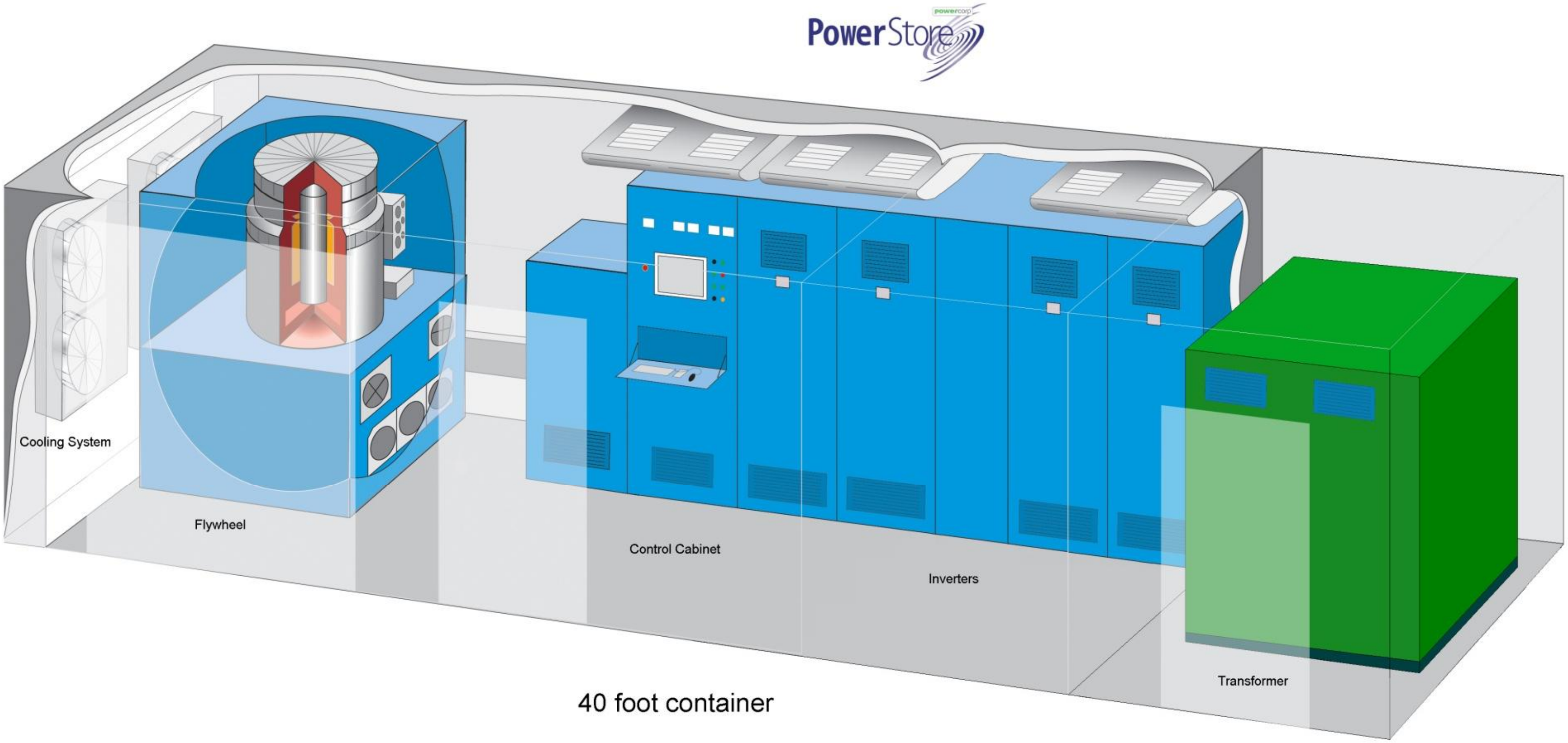
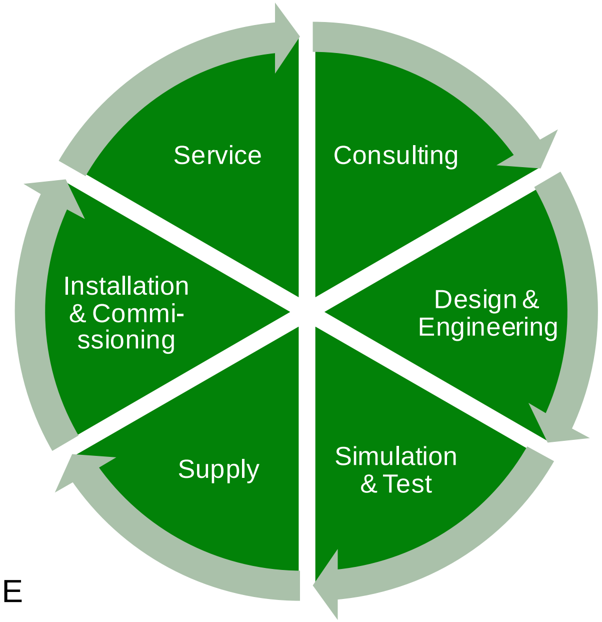
Offering
PowerStore-Flywheel System Schematic



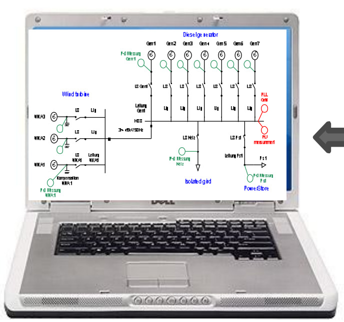
Offering
Complete Engineering Design Process



- Grid Stabilising
- Grid Connection RE
- Energy Storage
- Integration Algorithms
  - Generators
  - RE Generators
  - Demand Response
  - Storage

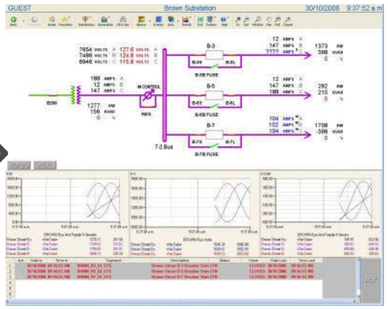
- Acceptance Testing
- Test and Verify Control
- Test and Verify SCADA
- Handover

- Operator Training
- Optimisation



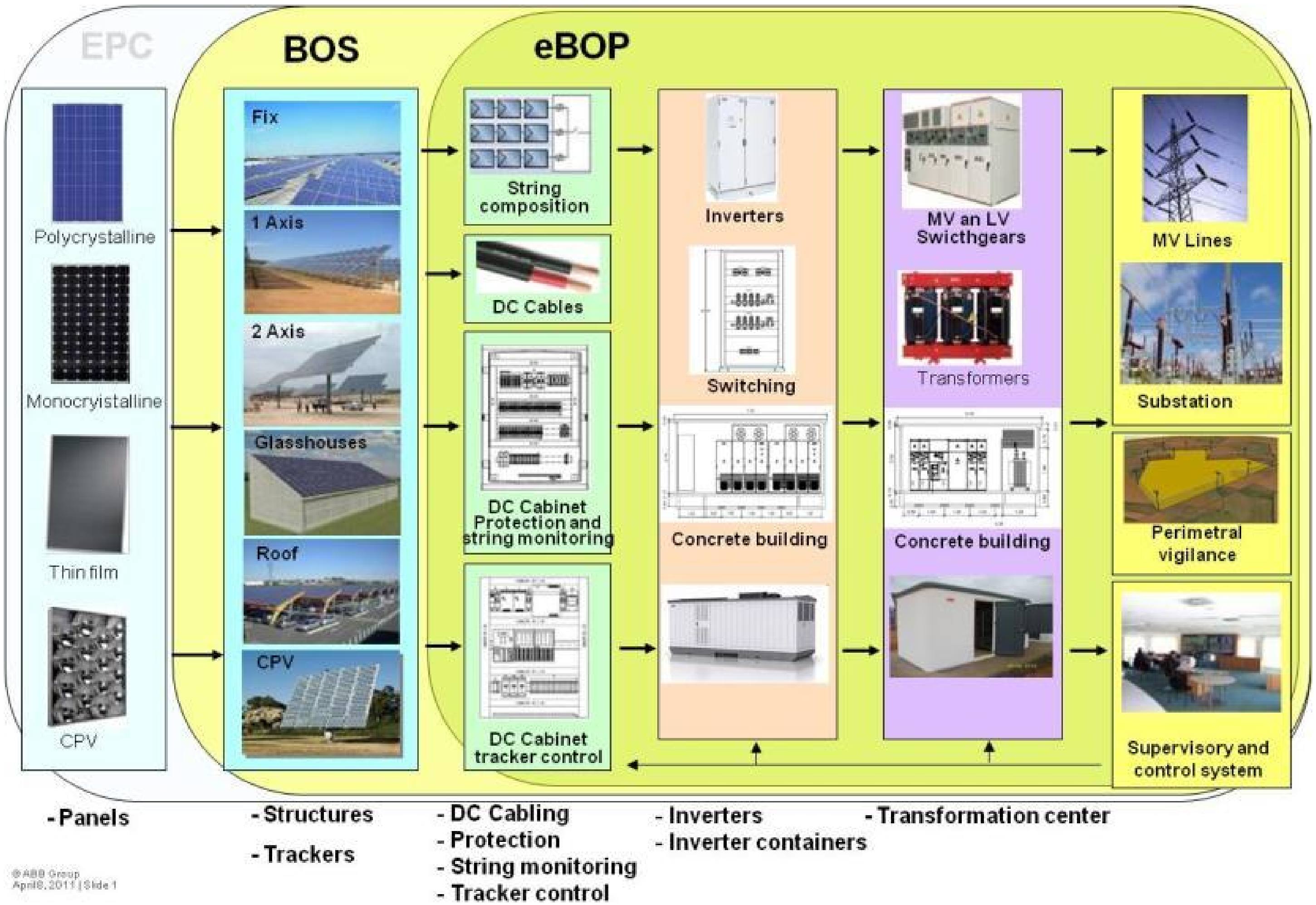
Power System Simulation

Control System



SCADA System

Extended capabilities as part of ABB
Complete eBoP and PV BoS as per std BU PSPG strategy



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